Analysis of the Relationship among Innovation Performance, Economic Development and Social Welfare

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SUMMARY

In our modern world everything is related: without innovation performance there is no economic development, without economic development no improvement can be found in social welfare and vice versa. In this study I explore the relationship among these three key factors with the help of statistical methods. Before that I give a brief summary on the indices that makes the measurement of the above-mentioned fields possible. After that I carry out statistical description of these relationships by pairs with the method of correlation analysis. Results obtained on the basis of data of the European Union member states prove that relationships among innovation performance, economic development and social welfare of countries are very strong and statistically significant. Furthermore, analysis described in the paper also proves that increasing innovation performance has a positive effect on different dimensions of social welfare.

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INTRODUCTION

Research and development and innovation has an indisputable role in increasing the economic competitiveness of a country or a region and also indirectly in creating social welfare (Pitti 2006). Theoretical and practical professionals have been interested in this issue for decades, what is more for centuries. However it was not always called research and development and innovation but simply technological development (Pakucs 2003). Nowadays the significance of research and development results, new or significantly improved products, services, processes, marketing and organisational innovations in each economic branch has been increasing (Török 2006). There is growing interest in connection with the topic among the government, businesses and public opinion as well, since performance in the field of science and technology is an alternative tool for economic prosperity on the individual, corporate and macroeconomic level.

The aim of the present study is to give a brief overview about the measurement methods of innovativeness, economic development and social welfare. After that I will describe the relationship of these three key factors as well the effect of innovation performance oncertain dimensions of social welfare.

LITERATURE REVIEW

Measuring innovativeness

Researchers have been interested in the measurement of innovative activities and performance for a long time. There have been a lot of experiments carried out to develop more relevant, precise (easier to compare, more complete, etc.) methods. OECD and its organisations are the most important among the international organisations and different countries' science and technology political institutions andhave had an indisputable role in this field in the past thirty to forty years. I would like to highlight the Oslo Manual (OECD 2005),which has widespread professional recognition. We distinguish among measurement methods thematic indicators, scoreboards handling index-groups, composite indicators created from indices and complex assessment techniques (measurement models). The most important

composite indicators of innovativeness applied in international comparison are the following:

- Summary Innovation Index (SII) (Hollanders & van Cruysen 2008; EC 2009)
- Regional Innovation Index (RII) (Hollanders et al. 2014)
- Global Innovation Index (GII) (Dutta et al. 2014)
- Global Competitiveness Index (GCI) twelfth pillar (WEF 2009)
- Knowledge Economy Index (KEI) and Knowledge Index (KI) third pillar (WB 2009).

Beside the above-mentioned indices the following organisations have also developed their own indices that have beenapplied to compare research and development and innovation performance on an international level. Whilethese methods do not have theirown "brand" name, for their identification the name of the developing organisation can be used.

- International Institute for Management and Development (IMD),
- National Science Board of the USA (NSB),
- Research and Development Corporation (RAND Corporation),
- United Nations Development Programme (UNDP),
- United Nations Industrial Development Organisation (UNIDO), or
- United Nations Conference on Trade and Development, (UNCTAD).

However these attempts were made for asingle year and did not continue (IMD 2009; NSB 2008; Wagner et al. 2001; UNDP 2007; UNIDO 2005; UNCTAD 2005).

In my own research Iapply the Summary Innovation Index for the measurement of innovation performance for the following reasons:

- This index traces back to the earliest times among the innovation composite indicators (the first version dates back to2001 and it has existed since then). The same can not declared about several other indices, many of which were forgotten after a year.
- The Summary Innovation Index isactulised from year to year, its methodology is supervised, and it is also corrected if necessary to give a more complex and precise picture about the innovation situation of countries.
- This composite indicator consists of 25 innovation indices which cover the input, process and output sides of innovation activity, as well.
- It is an indicator accepted Europe-wide both among science and technology political decision makers as well as in the academic sphere.
- Numeric values of the indicator (database) areeasily accessible.

It is important to mention that the Summary Innovation Index (SII) is a composite indicator of aggregated national innovation performance which is set up by 25 indices of the Innovation Union Scoreboard (IUS) (Hollanders & Es-Sadki 2014). Figure 1 shows indicators creating the SII and their structure.

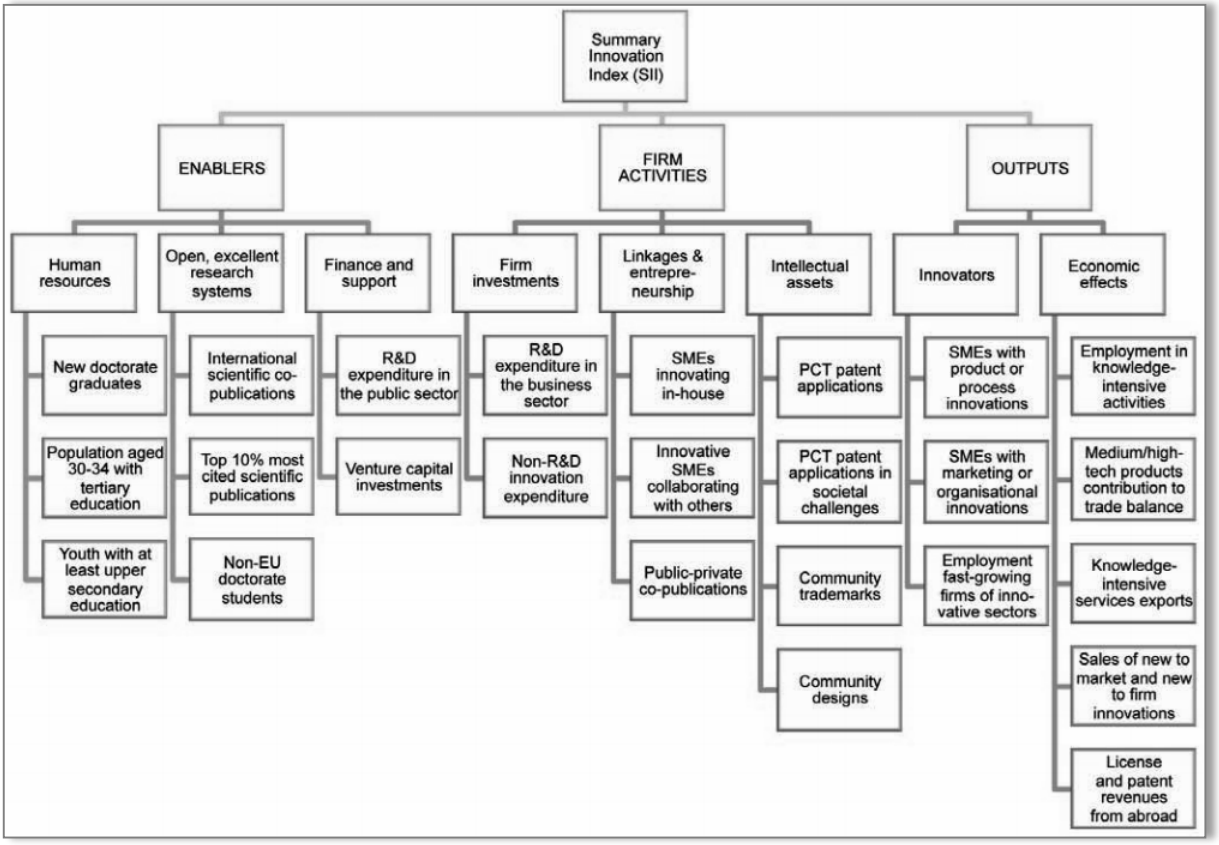

Figure 1. System of 25 indicators serving as a basis for the Summary Innovation Index
Source: Hollanders & Es-Sadki, 2014

Calculation of this complex index is carried out in eleven steps according to sophisticated statistical methods (Hollanders & Tarantola, 2011).According to the values of the Summary Innovation Index the countries can be put into four groups: innovation leaders, innovation followers, moderate innovators and modest innovatiors. Earlier, groups were created by hierarchic claster analysis (average chain between groups method, squared Euclidean distance) (Hollanders & van Cruysen, 2008). The latest methodology is carried out as follows(Hollanders & Tarantola, 2011):

- „innovation leaders": performance>1.2*EU-average
- „innovation followers": 1.2*EU-avearage>performance>0.9*EU-average
- „moderate innovators": 0.9*EU-average>performance>0.5*EU-average
- „modest innovators": 0.5*EU- average > performance

Indicators of economic development

There has been a lot of criticism in connection with the application of GDP, the most popular comprehensive indicator showing the common effect of several factors (Kristóf 2003). Despite this fact I will use this indicator (GDP) for the measurement of economic development in my own research. The most important criticism in connection with this indicator is that this is economic index in a narrow sense, yet GDP is used for describing economic welfare. Further limitations of GDP are detailed by Kristóf (2003) using statements of Heltai (1999), Csath (2001) and ECOSTAT (2002):

- GDP only gives a real picture about the incomes of certain people in countries with less concentrated income. In case of significant income concentrating ina smaller portion of society (rich people), the majority of the society lives below the average income level.
- GDP per capita is calculated bya common exchange rate (often in an actual average currency exchange rate) in order to make it comparable, therefore the GDP index is influenced by exchange rate volatility.
- Black economy includes activities that bring relatively high income to certain people but do not actually appear in the GDP.
- GDP does not consider welfare decrease due to environmental harm, but at the same time protection against environmental damages is included in the GDP.
- Production in non-market way (for example certain household work, agricultural activities) is not included in GDP.

Measurement of economic development has improved in three directions (Gáspár 2013). One of the directions is toapplythe GDP and supplementit with social and environmental indices. Several indicators has been createdin the field of education, health care, poverty, environment and social participation so far.

Another direction for development has beenthe correction of GDP; it was completed with social and environmental costs that has not been included so far. The most popular ones are the following:

1972 - Measured economic welfare, net economic welfare

1989 - Index of sustainable economic welfare

1995 - Genuine progress indicator.

The third direction of such measurements tried to replace GDP with composite indicators (that contain a refined form of gross domestic product:

1979 - Physical quality of life index

1990 - Human development index

1992 - Life product index

1995 - Basic and advanced quality of life index.

GDP was chosen for my own research because in every further developed indicator of economic development GDP – as you could read above - is applied in some way, as the best known, so-called coreindicator of the topic.

Indicators of social welfare

Measurement of social welfare has a long history; the Gallup Institute in the United States has been examining satisfaction since 1948. However it only spread in Europe at the end of the1970s and in the 1980s. The first international surveys werecarried in the 1980s. There has been growing interest in connection with the topic since the 1990s, both from the side of political decision makers and public opinion (Gáspár 2013).

Social welfare is basically a summary of individual life quality that could be described by individuals' satisfaction and happiness with their lives and life circumstances (Hegedűs 2001). However welfare has no generally accepted definition, therefore it exists with the following competitive interpretationin the professional literature: life quality, welfare, high living standard, level of life quality, utility, satisfaction, prosperity, meeting needs, development, social inclusion, development of abilities and skills, human development and more often happiness (McGillivray & Clarke 2006).

The most important surveys and comparisons ofthe internationally widespread ones are the following (Gáspár 2013):

- World Value Survey (survey of values and cultural changes)
- Gallup World Poll (Gallup-Healthways welfare index)
- New Economics Foundation (Happy Planet Index)
- International Social Survey Programme (happiness data)
- European Social Survey (value and lifestyle surveys)
- European Values Study (investigating what people think about their lives, jobs, families, religion, society and politics)
- Euromodul (measurement of life circumstances and life quality)
- Eurobarometer (survey focusing welfare)
- European Quality of Life Survey
- OECD Better Life Index (economic, social and environmental indices).

I chose the OECD Better Life Index (BLI) in my research for the following reasons:

- Although the first edition appeared in 2011, preparation lasted for nearly 10 years. This was the first experiment to create a method for international comparison of welfare that also considered suggestions of Commission on the Measurement of Economic Performance and Social Progress (also called the Stiglitz-Sen-Fitoussi Commission).
- This composite indicator consists of 24 indices that cover all the dimensions focusing on people's present and future welfare.
- It is accepted not only in Europe but also all over the world. It is also recognised by theoretical and practical experts, who refer to this composite indicator many times.
- Last but not least, the database is also easy to access and contains concrete values.

It is important to know thatthe indicator aggregates the information of 24 indices that cover 11 dimensions of social welfare. The system of dimensions and indices is contained by the following list:

1. Housing: Dwellings without basic facilities; Housing expenditure; Rooms per person
2. Income: Household net adjusted disposable income; Household net financial wealth
3. Jobs: Employment rate; Job security; Long-term unemployment rate; Personal earnings
4. Community: Quality of support network
5. Education: Educational attainment; Student skills; Years in education
6. Environment: Air pollution; Water quality;
7. Civic engagement: Consultation on rule-making; Voter turnout
8. Health: Life expectancy; Self-reported health
9. Life Satisfaction: Life satisfaction
10. Safety: Assault rate; Homicide rate
11. Work-life balance: Employees working very long hours; Time devoted to leisure and personal care.

The index is unique because the weights of dimensions can be chosen as wished, so anybody can create his own social welfare indicator by changing dimension weights. Thisis illustrated by an interactive application on the home page of the Better Life Index http://www.oecd-betterlifeindex.org/).

DATA AND METHODS

In the rest part of my research I carried out the analysis of relationship among the three key factors mentioned above:

1. **innovative performance,**
2. **economic development,**
3. **social welfare.**

I chose the Summary Innovation Index (SII) to measure innovative performance and GDP per capita on purchasing power parity to measure economic development. Regarding quantifying social welfare I applied the OECD Better Life Index (BLI). For the three indices I carried out data collection concerning the 28 member states of European Union. The data of the SII is completely available in the publications of European Commission (see Hollanders & Es-Sadki, 2014). GDP data are also accessible on the homepage of the Hungarian Central Statistical Office. However data of the BLIindex are only available forOECD member states, therefore data are missing in case of seven countries of the European Union (Bulgaria, Cyprus, Croatia, Lithuania, Latvia, Malta and Romania).

In order to describe relationship in my research, I set up a so-called framemodel (framemodel for relationship among innovative performance, economic development and social welfare, see Figure 2). It is obvious from the figure that innovation performance (at present SII) relies on three pillars, these are the so-called enablers, firm activities and outputs. These pillars are created by further dimensions (8) and they can also be divided intofurther indices (24). Another majorelement of the model is economic development, and the third one is social welfare which – as you can see below – is also created by a number offactors (24 indicators setting up 11 dimensions).

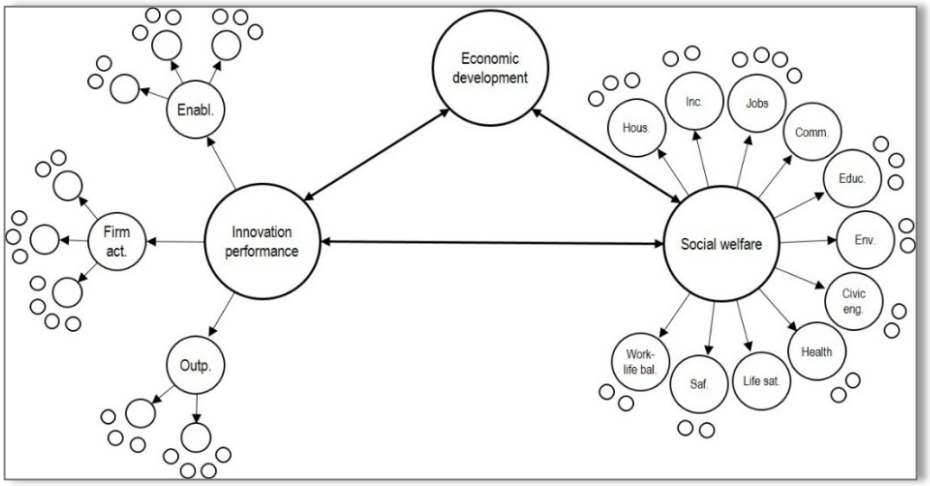

Figure 2. Framemodel of relationships among innovation performance, economic development and social welfare
*Source:*Compiled by the author

Relationships among the key factors were examined by pairs with the help of correlation analysis and strengths of relationships were quantified by Pearson's simple linear correlation coefficient.

MAIN FINDINGS

After the analyses were carried out, conclusions could be drawnregarding the relationships among innovation performance, economic development and social welfare:

A strong significant relationship (r=0.726; P=0.000) is shown between innovation performance (SII) and economic performance based on 28 European Union member states (Figure 3).If we suppose that innovation performance influences economic development then we can set up the following linear regression equation: y=6219.5+52400x (where y=GDP, x=SII), therefore a 0.1 increase in innovation performance causes $5240 per capita GDP growth. (Determination coefficient of regression function (R^2=0.83) shows excellent fit.)

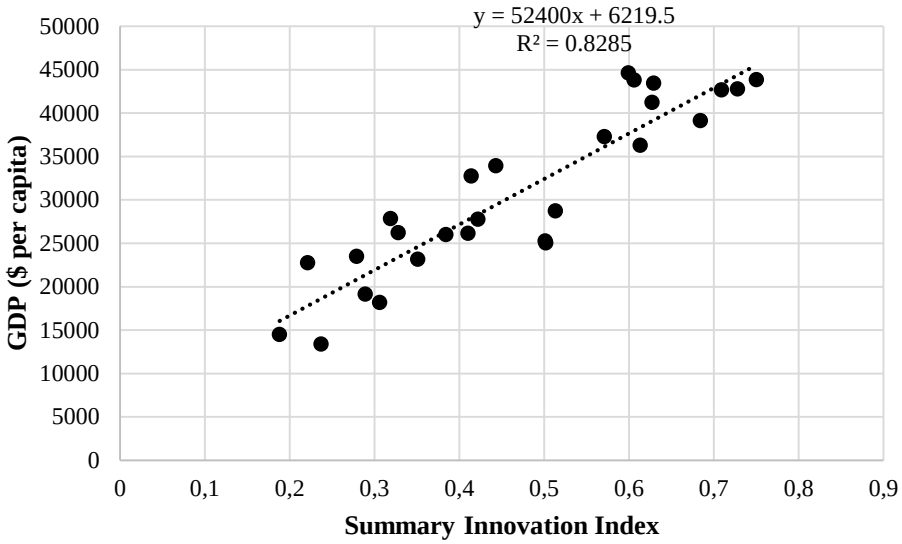

Figure 3. Relationship between innovation performance (SII) and economic development (GDP)
Source:Compiled by the author

Results obtained – whilebased on another methodology –support results of Pakucs's (2003) synthesising study concluding that there is a significant positive relationship among research and development and productivity as well as economic growth. Szalavetz (2011), who examines the issue of innovation driven growth,has similar results. In her conclusion she emphasises the positive economic and productivity effects of technological innovations. I would also highlight Rosenberg's (2004) results from an international aspect;he found that technological innovation is a main force for economic growth according to analysis on the basis of OECD member states.

There is also a significant relationship (r=0.894; P=0.000) between innovation performance (SIII) and social welfare (BLI) based on data of 21 EU member states. If we also suppose innovation performance as the explanatory variable of social welfare then the following regression equation can give us more information about their relationship (Figure 4): y=0.29+0.68x (where y=BLI, x=SII) therefore a 0.1 increase in innovation performance of a given country causes about 0.07 growth in social welfare index. (Fit of the regression equation is excellent as well: R^2=0.80).The figure shows that in the lower interval of SII and BLI correlation is weaker, yet it is stronger in the higher interval. In order to reveal the cause of the difference further investigations are needed; however, that is not the primary purpose of this paper.

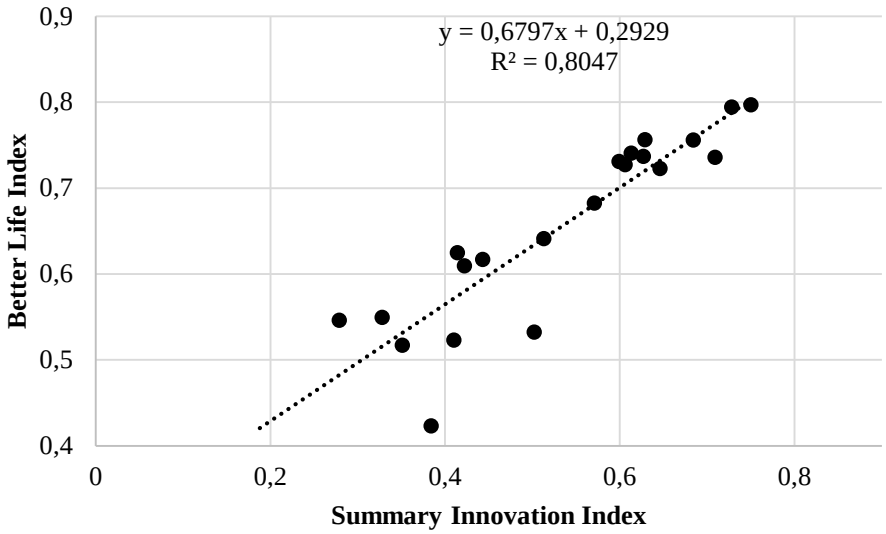

Figure 4. Relationship between innovation performance (SII) and social welfare (BLI)
Source:Compiled by the author

Although the results of this study show a clear relationship between innovation performance and social welfare, the results of Bajmóczy and Lengyel (2010) differ. They found a complex relationship between innovation and welfare that cannot be handled schematically. However, it is true that their research focused on only one Hungarian region (South Great Plain). Málovics and Bajmóczy (2010) also concluded on the basis of sub-regional level research that different welfare situations can be connected to the same innovation ability and – although their research is indecisive – there was a correlation between innovation and only some dimensions of welfare. From an international aspect we can find confirmation from the European Research Council (ERC), according to which innovation is very important from the aspect of economic and social welfare and what is more, the Innovation Union concept is based on this fact.

There is also a significant relationship between economic development and social welfare (BLI) and this correlation is medium strong (r=0.599; P=0.000). According to my third hypothesis, economic development affects social welfare (Figure 5). Linear regression between these two variables can be described with the following function: $y=0.22+0.0125*10^{-3}x$ (where y=BLI, x=GDP) therefore a $1000 increase in GDP per capita brings 0.0125 growth in the social welfare index. (Fit of linear function is excellent: $R^2=0.84$.)

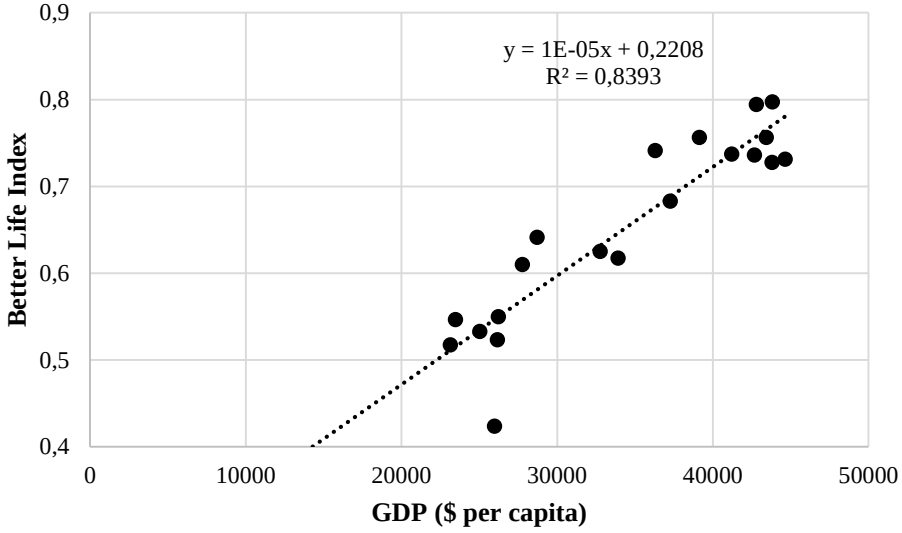

Figure 5. Relationship between economic development (GDP) and social welfare (BLI)
Source: Compiled by the author

Economic development and social welfare are in strong relationship with each other, so much so that they

are handled as synonyms: economic-social development/welfare. Husz (2001, cited in Kristof 2003) says that despite the strong relationship, increasing output is necessary for but not enough to achieve the improvement of social welfare, it is only a possible tool for it. Kopp and Martos (2011) also examined the relationship of these two factors in their study. They say that change in life quality is not linear or have a direct relationship with economic development. It is not true that economic development brings welfare and an increase in happiness. Certain indicators can even worsen with economic growth. The apparent contradiction between my results and theirsmay be explained by the following fact: their study used national longitudinal data while I used my own international comparison.

After exploring and describing more general relationships I examined the effect of innovation performance on certain indices of social welfare. I chose correlation analysis and I summarised significant relationships in Table 1.

Table 1
Relationship between innovation performance and indicators of social welfare

Dimension	Indicator	Correlation coefficient (r)	Significance level (P)
Housing	Rooms per person	0.782	0.000
Income	Household net adjusted disposable income	0.776	0.000
	Household net financial wealth	0.655	0.001
Jobs	Employment rate	0.756	0.000
	Long-term unemployment rate	0.594	0.005
	Personal earnings	0.804	0.000
Community	Quality of support network	0.520	0.016
Environment	Water quality	0.768	0.000
Civic engagement	Consultation on rule-making	0.523	0.004
	Voter turnout	0.758	0.000
Health	Life expectancy	0.528	0.014
	Self-reported health	0.553	0.009
Life satisfaction	Life satisfaction	0.833	0.000

Source: Compiled by the author

There is a strong, positive, significant relationship ($0.7<r$) between innovation performance and several indices of social welfare: Rooms per person (Housing); Household net adjusted disposable income (Income); Household net financial wealth (Income); Employment rate (Jobs); Personal earnings (Jobs); Water quality (Environment); Voter turnout (Civic engagement); and Life satisfaction.

Furthermore there is a medium-strong, positive, significant relationship ($0.4<r<0.6$) between innovation performance and long-term unemployment rate (jobs), quality of support network (community); consultation on rule-making (civic engagement), life expectancy (health) and self-reported health (health).

CONCLUSION

I examined measurement methods of innovation performance, economic development and social welfare as well as the relationships among these key factors. The most important findings of the research can be summarised as follows.

Several methods are available for the measurement of innovation performance and there is much interest in so-called composite indicators. Many of them are available toanybody (namely SII, RII, GII, etc.). Since there has been much criticism of the most widespread index of economic development, GDP, there have also been many experiments to create alternatives. However, these alternatives also contain GDP more or less. There are some that complete, correct or refine GDP. Measurement of social welfare has a long history and a lot of international surveys and comparisons dealt with the topic. The starting point was a summary about individual life quality in every case that can be completed with economic and environmental indices (e.g. Happy Planet Index, Better Life Index, etc.)

The three key factors of my investigation (innovation performance, economic development, social welfare) are without any doubt strongly related with each other,ascan be proved by the significant correlation relationship by pairs. As a causal examination was also carried out, we can state that motivating innovation activity and performance has a very positiveimpact on the economic development and social welfare of a country as well.This is supported by the fact that a strong or medium strong relationship was identified between innovation performance and a number of indictors of social welfare.

Further growth in innovation performance on the macroeconomic level can lead to extremely positive changes in social welfare. The road ahead is long and difficult, but if we follow the philosophy of Thomas A. Edison, it might be easier to travel it: "*I have not failed, I've just found 10,000 ways that won't work.*"

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